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Jack Zagar has twenty-five years experience in North Sea, Middle East, Gulf of Mexico, and onshore U.S.A. operations in petroleum reservoir engineering and reservoir management; economic evaluations of projects, property trades, and asset sales; and corporate planning. Twenty-two years were with Exxon Corporation and Exxon U.S.A. The last three years Mr. Zagar has been engaged as an independent engineering consultant. Mr. Zagar is also an associate of Malkewicz-Hueni Associates of Golden, Colorado and is partnered with noted author and world oil reserve expert, Dr. Colin Campbell.

Dr. Colin Campbell took a D.Phil. in geology at Oxford in 1957 before joining the oil industry as an exploration geologist, working in Trinidad, Colombia and New Guinea. In 1968, he joined Amoco in New York with responsibility for worldwide new ventures and world resource assessment. In 1969, he was appointed the company's Chief Geologist in Ecuador. In 1972 he was appointed General Manager of a Texas independent's North Sea operations, before returning to Amoco as Exploration Manager in Norway in 1980. In 1984, he accepted an offer to become Executive Vice-President of Fina in Norway. In 1989 he became an independent consultant advising governments and major oil companies. He has written two books - *The Golden Century of Oil* and *The Coming Oil Crisis* - and has published widely, lectured and broadcast on oil depletion. Presently, Dr. Campbell is a partner of PetroPlan, Inc.

The End of Cheap "Conventional" Oil

by

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ABSTRACT

Easy to find and cheap to produce "conventional" oil in huge quantities has fueled and satisfied the World's thirst for energy this century. About 95% of all oil produced—and 90% of today's production—comes from this group of hydrocarbons. But this century of the new millennium will see the decline and exit of conventional oil as a major player on the World's energy stage. Already, outside the Middle East, conventional oil production is on the decline. And the Middle East with its vast reservoirs of oil will soon reach the mid-point of depletion and begin its irreversible decline. Currently, one barrel of conventional oil is being found for every four barrels that are produced. The Middle East now supplies 30% of the World's conventional oil production and their share is rising because, unlike in the 1970s, no new major provinces, save perhaps the Caspian, are there to deliver flush production. The stage is now set for another "energy crisis" starting with higher prices from Middle East control and followed by the onset of physical shortage around 2010. We face something new to human experience.

The End of Cheap Oil

A Turning Point for Mankind

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<CHART 2> Title slide

GOOD MORNING ladies and gentlemen! I would like to thank the organizers for inviting me to be with you today to speak on this increasingly important subject. My partner Dr. Colin Campbell sends his apologies for not being here to speak with you personally.

<CHART 3> Purpose of Presentation

The purpose of my presentation is to, primarily, provide you with a global perspective on the production and depletion of that fundamental commodity—crude oil—that has driven the World's economies since the middle of the last century; and, then to, briefly, offer some insights as to what this all means insofar as Hawaii's energy consumption and policies are concerned.

Purpose of Presentation

- Global perspective on production and depletion of World oil reserves
- Insights regarding Hawaii's energy consumption and policies

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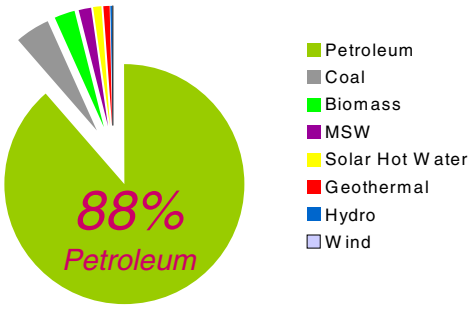
Hawaii's Energy Consumption

Year 2000



Increasing 2.8% per year vs. World's ~1%

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<CHART 4> Hawaii's Year 2000 Energy Consumption

On a local level, petroleum based energy is the lifeblood of Hawaii, accounting this year for nearly 90% of the energy consumed. Hawaii's total energy consumption has increased on average 2.8% per year since 1994 compared to the World" annual average of 1.8%.

<CHART 5> Hawaii's Petroleum Supply

Hawaii imports <u>daily</u> nearly 140,000 barrels of crude oil and 24,000 barrels of refined petroleum products of which 72% and 79%, respectively, come to Hawaii from sources outside the United States.

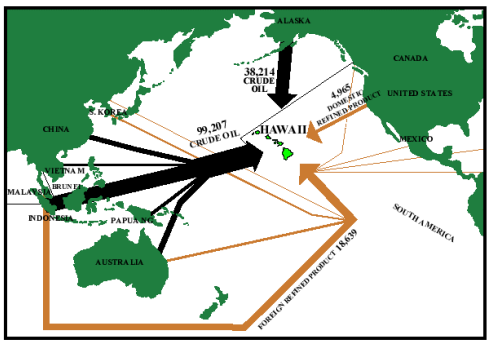
Let me just say up front that I want to get away from the notion of "running out of oil". With the tremendous resources of heavy oils and tar sands in the world, and the likes of oil shales and conversion of natural gas to oil, <u>running out of oil will not happen for a long time</u>.

Hawaii's Petroleum Supply

Year 1999

Foreign Sources:

72% of Crude Oil & 79% of Refined Petroleum Products



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Historical Discontinuity

- When does World oil production peak?
- What type of oil controls peak?

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<CHART 6> Historic Discontinuity

Whenever I speak of the end of cheap oil, I am talking about an *historic discontinuity*, namely: *When does world oil production peak and begin its irreversible decline? And what type of oil controls peak production?* Most global economies are expanding and are expected to continue to do so. And with this expansion, cheap oil production is expected to keep pace fueling this growth. Well, what if the growth in low-cost oil production does not materialize? Let's investigate . . .

Categories of Petroleum

- "Conventional"
  - ✓Primary, routine water/gas floods, pressure maintenance, artificial lift, "improved recovery"
- "Non-conventional"
  - ✓Heavy, extra heavy, tar, oil shale, synthetic
  - ✓Deepwater, polar, enhanced recovery
  - ✓High temperature-high pressure (HTHP)
  - ✓Coalbed methane
  - ✓Gas-tight, biogenic, hydrates, etc.

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<CHART 7> Categories of Petroleum

The first and most difficult step is to define what we are talking about. It has been common practice to distinguish *conventional* from *non-conventional* hydrocarbons. Some people define as *conventional*: all oil that is commercially producible at a given date. This approach means that nothing can be measured because the goal posts move all the time.

Instead, I recognize that the family of hydrocarbons is a large one. Each member has its own endowment in Nature, its own characteristics, costs, and depletion profile. It is obvious that you can deplete light oil flowing at 20,000 barrels a day from a Middle East well much more quickly than you can extract oil from a tar sand in Canada. About 95% of all oil produced to date—and 90% of today's production—comes from this group of hydrocarbons which I will call "*conventional*" for want of a better word. It will continue to dominate supply until well past peak. This is what matters most, and I will concentrate on it today.

Non-conventional oils, most of which are listed on the lower half of this slide, are a large resource but most are slower and significantly more costly to produce. They become important primarily after peak, but they do shift peak by a few years

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Two Simple Questions

- How much oil has been found?
- When was it found?
  - ✓*Simple to ask, but difficult to answer...*

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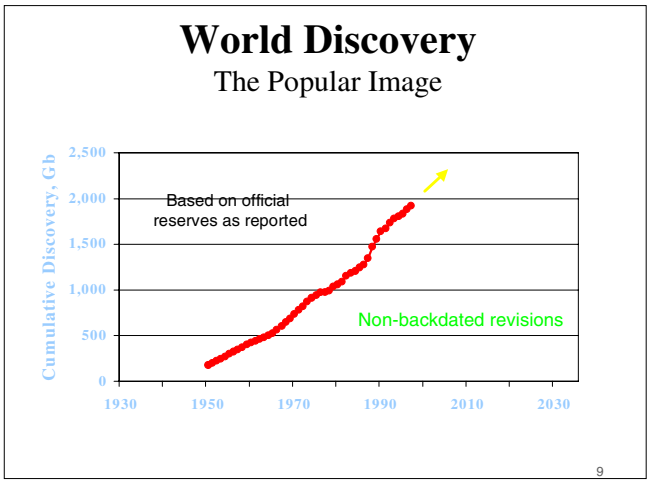
<CHART 8> Two Simple Questions

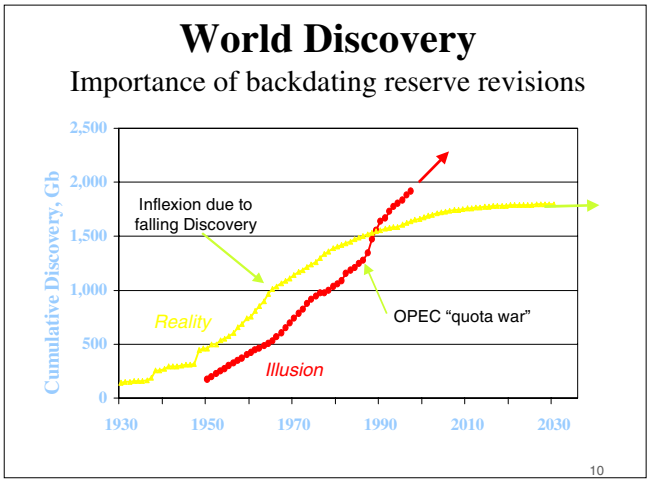
Once we have defined what kind of oil we are talking about, we have to ask two simple questions: (1) How much of this oil has been found? and (2) When was it found? These questions sound simple, but they are difficult to answer because the data are weak.



<CHART 9> World Discovery – Popular Image

This is the popular image based on official reserves as reported and promoted by oil companies. This is a plot of cumulative world oil discovery in billions of barrels versus time. It conveys the notion of discovering ever more oil, and is often explained by the ever-onward march of technology.

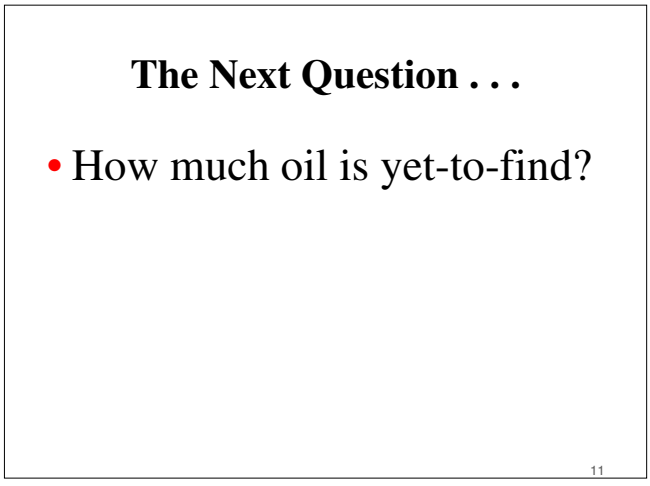
But, most of it is in the reporting, not in the reservoir. It simply reflects a correction of initial under-reporting due to the conservative booking of the reserves. This under-reporting is done for all sorts of good commercial and regulatory reasons and is the root cause of what is often referred to today as "reserve growth" in producing fields. The under-reporting is aggravated further by not back-dating the reserves to the earlier date when the field was discovered.



<CHART 10> World Discovery – Importance of Backdating

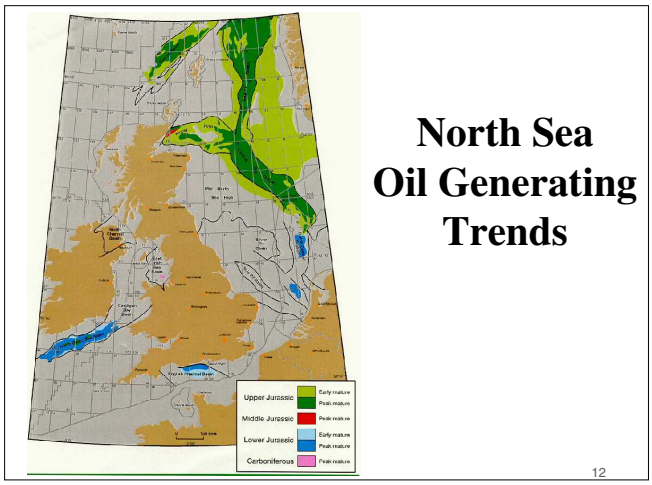
The reality of reserve projections is very different, once we use valid reserve figures properly backdated to their time of discovery. This chart is the same as the previous chart but back-dating the reserves and using the best reserve estimate I can make as illustrated with the yellow line. The bending over of this cumulative curve is due to a decline in the rate of discovery of which I will discuss later.

I have extrapolated the discovery trend of the yellow curve forward in time to open the next question: How much conventional oil is Yet-to-Find?



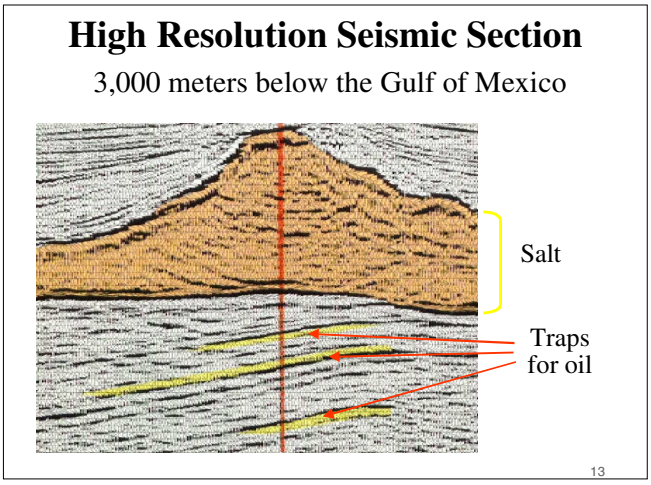
<CHART 11> The Next Question: How much oil is yet to find?

Most of the world's oil was found long ago with technology no more advanced than the hammer and hand lens. Some 60% lies in about 300 easily found giant fields. But over the last 20 years, we have seen amazing technological advances in the exploration arena.



<CHART 12>North Sea Oil Generating Trends – Geochemistry

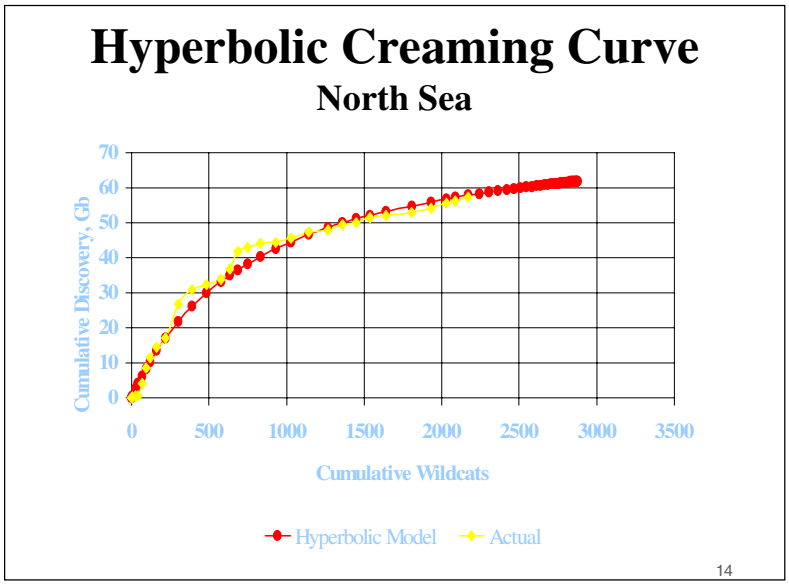
First, there is the geochemical revolution. In the 1980s, geochemistry allowed us to relate the oil in a well with the source rock from which it came. These techniques have allowed the industry to map and identify the oil generating trends of virtually the entire world. This example is of the North Sea. There is little possibility of finding oil outside these generating trends, and we now know where most of them are.



<CHART 13> High Resolution Seismic Section

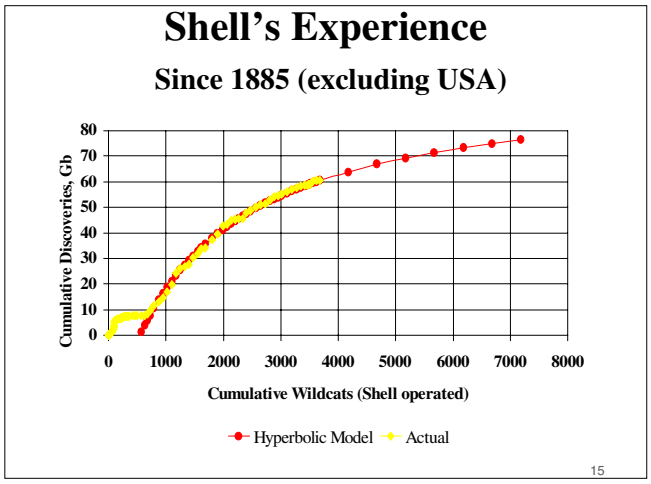
Then, there is the geophysical revolution that we hear so much about in the way of 3-dimensional and even 4D seismic surveys. This technology is equally successful in telling us where oil is NOT as well as where it is. This chart shows the amazing seismic resolution that is possible. We can now see even the smallest needle in the haystack and in some cases even the oil itself. But unfortunately, the needle is still a needle. We didn't need this resolution to find the giant fields that dominate world production.

As an aside—a giant field on the World stage is any field with 500 million barrels or more of reserves. It sounds big—and it is—but the current appetite of the World is such that it consumes the equivalent of one of these giants every week.



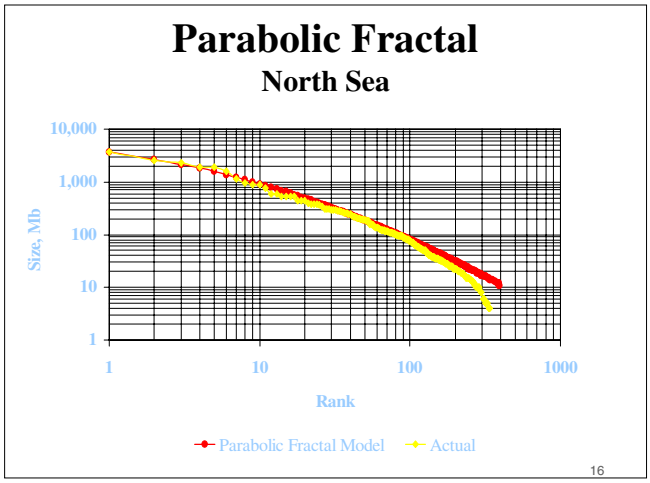
<CHART 14> Hyperbolic Creaming Curve – North Sea

We can also use statistical techniques. This so-called hyperbolic creaming curve is one of the more powerful tools. It plots cumulative oil discovery against cumulative wildcat exploration wells. This particular one is for the North Sea. The larger fields are found first; hence, the steeper slope at the beginning of the curve. Nearly 57 Gb have been found after drilling over 2,200 wildcats. Extrapolating the trend shows that double the exploration effort would bring only a tenth more. To find an entirely new basin after more than 30 years of exploration seems highly unlikely, save perhaps for the deep water.



<CHART 15> Shell's Experience – Hyperbolic Creaming Curve

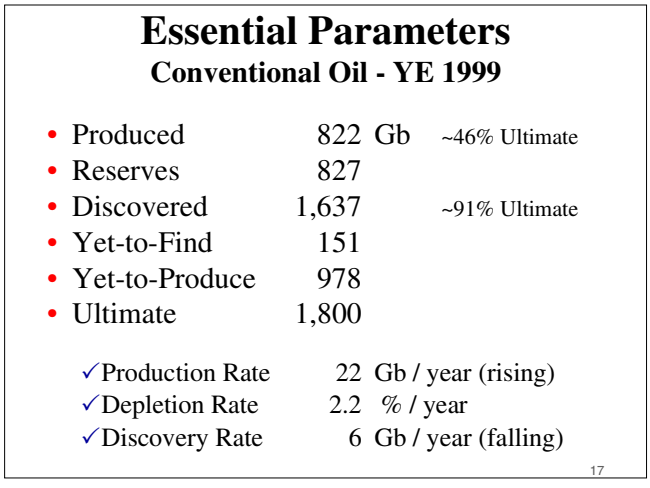
It is the same story with an individual company. Shell Oil is arguably one of the most successful explorers of the major international oil companies. Since 1885 Shell has found 60 Gb with 3,600 wells outside of the USA. If Shell drilled as many again it might find another 16 Gb. I could show you the corresponding plot for Amoco. This former oil giant found 15 Gb with 600 wells, but 14 of the 15 Gb came from the first 300 wildcats with hardly anything to show for the remainder. It perhaps explains why Amoco merged with BP.



<CHART 16> Parabolic Fractal – North Sea

Another statistical tool that we use is the parabolic fractal model. It relates field size with its relative rank. This particular one is for the North Sea. The yellow line is the size distribution of the actual fields. Once all the larger fields have been found, they set the parameters for the parabola or fractal model—the red line—which describes the whole distribution of the geologic province. The Yet-to-Find or undiscovered reserve is the difference between the model and the actual discoveries.

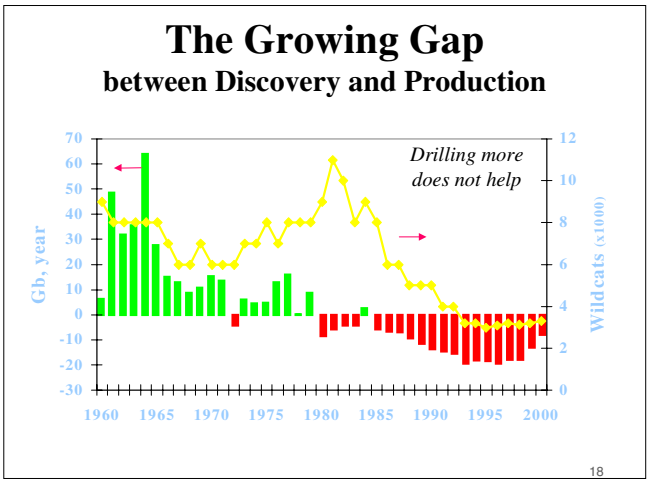
And there are other modeling techniques. These have all been applied as appropriate to all the basins and countries of the World to yield what I call in the next chart—The Essential Parameters for conventional oil.



<CHART 17>The Essential Parameters – Conventional Oil

It is convenient to keep the figures as computed but they could of course—and I emphasize—be generously rounded. The public records show that for the entire World, about 822 Gb has been produced year-end 1999. My assessment for the current most likely or probability-50 reserve outlook is about 827 Gb, giving a total discovered volume of a little more than 1.6 trillion barrels. To this I have added about 151 Gb as Yet-to-Find, bringing the total Yet-to-Produce to 978 Gb or to generously round, about 1 trillion barrels. Cumulatively, the World's endowment of conventional oil is approximately 1.8 trillion barrels of which we have produced about 46% and found 91% . Now, Dr. Campbell and I are not saying that more oil – beyond our estimate of 151 Gb – will not be found. But we are saying that these additional reserves will be discovered so far out in time that they will have no influence on World peak oil.

We are producing and consuming about 22 Gb a year or 2.2% per annum of the Yet-to-Produce, and we are less than 4 years away from the mid-point of depletion. Yet, we are finding only about 6 Gb a year and that trend is falling.



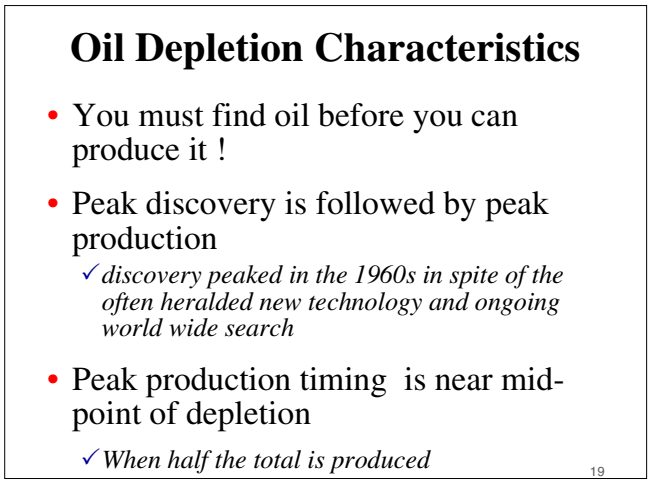
<CHART 18> The Growing Gap Between Discovery and Production

This growing gap or difference between discovery and production is perhaps better illustrated on the next chart. The discovery figures represented in this chart are all conventional discoveries—not just the conventional giants. Green vertical bars depict years where Discoveries exceeded Production. The red bars show years where Discoveries were less than Production. Discoveries peaked in the mid-1960s, and the industry continued finding more than it was producing up to about 1980.

The high oil prices of the early 1980s stimulated an enormous drilling effort, denoted here by this plot of world wildcat wells—the yellow line—but it did not change the underlying discovery trend. Because of the recent advances in technology it is much more difficult to drill a dry hole. About three weeks ago the Federal Reserve Chairman Alan Greenspan made this point when he was expressing his concerns over today's high oil prices and the impact on world economies. Industry's success ratio has increased but Greenspan did not mention that the amount of oil found is declining and, hence, fewer wells are being drilled. The oil industry is not willing to pay $100,000 per day rig rates for nothing.

Since the 1980s, production has not been replaced by new discoveries. 1999 and 2000 have been exceptional years with the discoveries of two super-giant fields in hitherto closed areas: the 5 Gb Azedegan field in Iran and the 10 Gb Kashagan field in the north Caspian Sea, the latter of which is the largest oil field discovered since Prudhoe Bay in Alaska in the late 1960s.

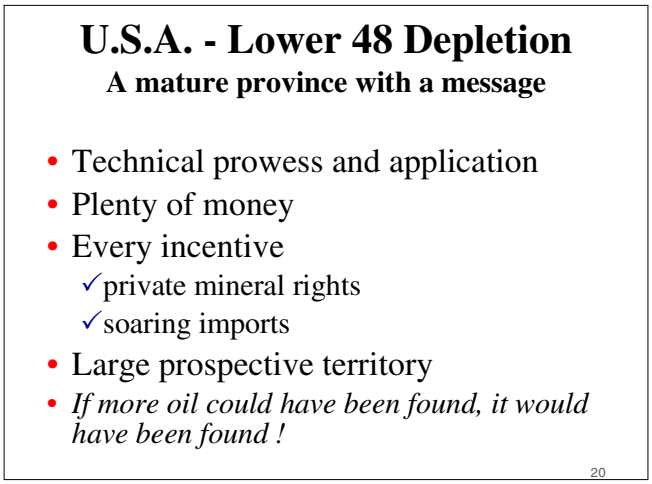
In other words, we now find on average only one barrel for every four we consume <This ratio is one found for every three consumed if you add the latest hot play Deep Water discoveries>. This fact is often clouded in annual reports by the inclusion of the "reserve growth" reserves discussed earlier.



<CHART 19> Depletion Characteristics

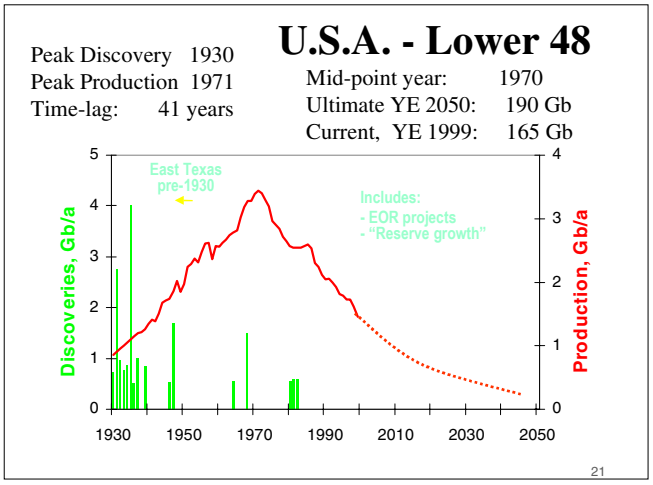
Given this depletion trend, I ask: *What will characterize the depletion of the remaining world's reserves? What forces will shape the second half of the world's oil production?*

When analyzing the data, it does not take long to come to three simple algorithms. First, "you have to find oil before you can produce it". This logic often escapes demand-side economists that see oil production as merely a function of the number of drilling rigs that can be built and wells that can be drilled. Second, peak oil discovery is followed by peak oil production. This seems intuitively obvious, but it has been overlooked by many. This, I think, is the strength of Dr. Campbell's thesis. It is a fact—not a forecast—that oil discovery peaked in the 1960s, in spite of new technology and an ongoing worldwide search, and that peak production will follow at some reasonable length of time thereafter. And the third algorithm is that the peak of production in any basin or country, and by extension the world, will come close to the mid-point of depletion, unless production has been artificially constrained. In other words, when half of the world's oil reserves have been produced, decline will set in.



<CHART 20> USA Lower 48 Depletion – A mature province with a message

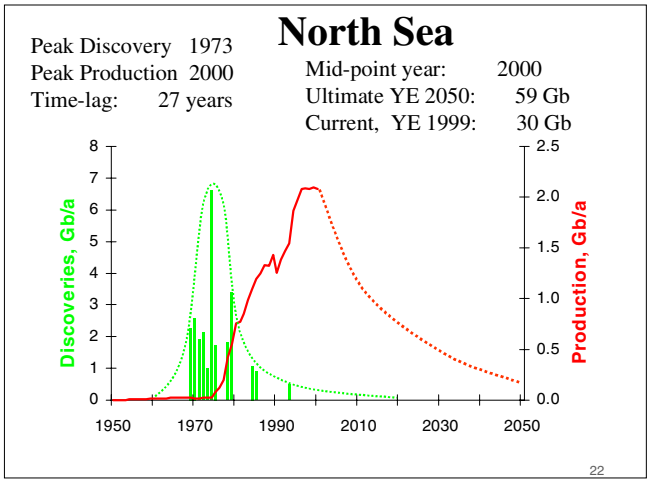
As an example, let's take a look at the World's most mature oil country – the United States – Lower 48. No one would argue that industry state-of-the art technology is readily brought to bear on whatever challenge presents itself in the way of exploration and exploitation. And that there is no shortage of money with which to leave no stone unturned. There is every incentive—from private ownership of mineral rights up through the Federal government's actions to reduce soaring oil imports that account for more than 50% of oil consumption. With 6% of the World's land area and over 4,000 miles of coast line, the USA represents a sizeable area for exploration. In short: *if more oil could have been found, it would have been found!*



<CHART 21>USA Lower 48 – plot of discoveries and production

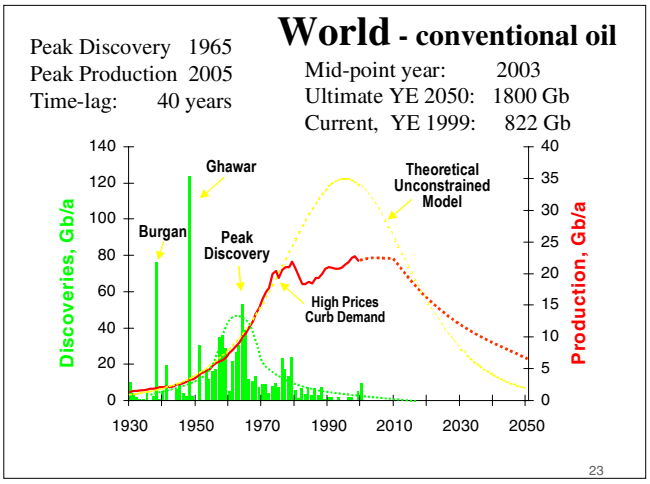
This next chart is a plot of oil production and giant field discovery for the USA Lower 48. The discoveries are shown by the green vertical bars and peaked in 1930. And no giant fields have been discovered since the early 1980s. Production is shown in red and peaked in 1971, only one year after the mid-point of depletion and nearly 40 years after peak discovery. The solid red line depicts actual reported production, while the red-dashed line is my base production forecast. Not only does this chart include my conventional classification of oil, but also oil from EOR (Enhanced Oil Recovery) projects such as miscible, chemical or thermal floods and the so-called reserve growth production. In other words, just about everything onshore and from the shallow continental shelf.

No one, I think, would dispute that the post-peak decline is a robust trend that cannot be reversed. Everything that can be done is being done. The large fluctuations in price and the many advances in technology have barely affected production. Or one could argue that without all the advances in technology, the decline would have been even steeper.



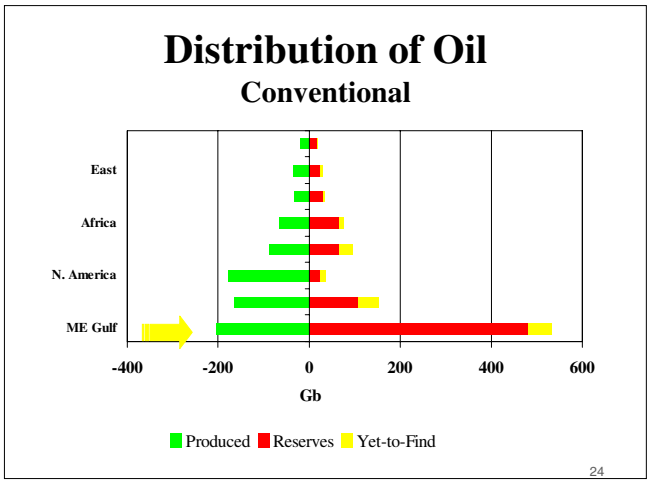
<CHART 22> North Sea – plot of discoveries and production

Now let's look at the North Sea which is now the second largest exporter after Saudi Arabia. We again see the early peak of discovery, which was in 1973. This is fact—not hypothesis. We cannot see peak production so clearly because we are standing on it. We are there all the same. Note particularly the impact of all the amazing technology that has been deployed in the North Sea. It has reduced the time lag from peak discovery to peak production, compared to the US-48, from 42 to 27 years. We are getting much more efficient at depleting our petroleum resources.



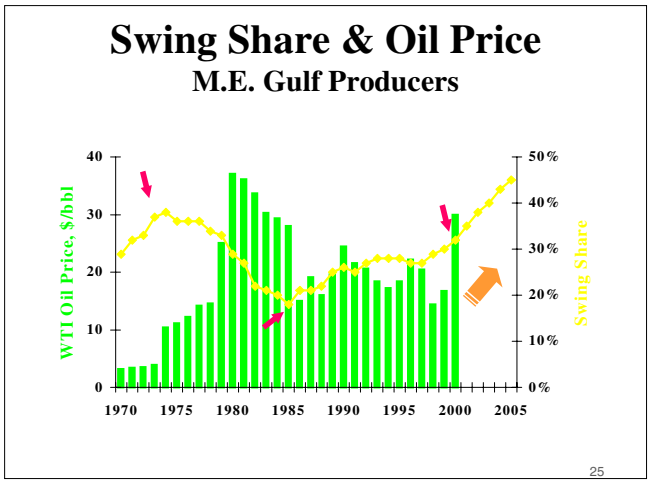
<CHART 23> World – plot of discoveries and production

This next chart is a similar plot of the World's conventional oil production. World giant oil discoveries peaked in the mid-1960s. The theoretical unconstrained production model is shown by the yellow dashed line. It is often referred to as a Hubbert curve, named after the famed Shell geologist who predicted the peak of the USA production 15-years before it did, using such a mathematical curve. The actual production peak relative to the theoretical unconstrained peak is often capped for all sorts of reasons, like cheap imports, market forces or constraint by regulatory agencies. There was a close match to the theoretical curve until the price shocks of the 1970s when high prices curbed demand. Peak has been delayed a few years and the forecasted decline is less steep than would have otherwise been the case.



<CHART 24> Distribution of Conventional Oil

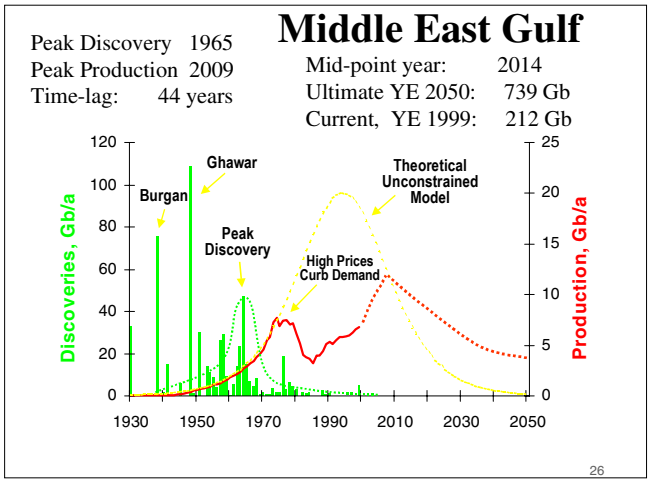
This chart summarizes the uneven distribution of conventional oil in the World. Produced oil is shown in green. The Yet-to-Produce is comprised of the known Reserves (shown in red) and the Yet-to-Find (shown in yellow). The key point here is that about half of the Yet-to-Produce lies in just five Middle East Gulf countries. These five key Middle East Gulf countries—Iraq, Iran, Kuwait, U.A.E and Saudi Arabia—are natural *"swing producers"* around peak. That is, they can make up the difference between world demand under various scenarios and what other countries can produce.



<CHART 25> Swing Share & Oil Price

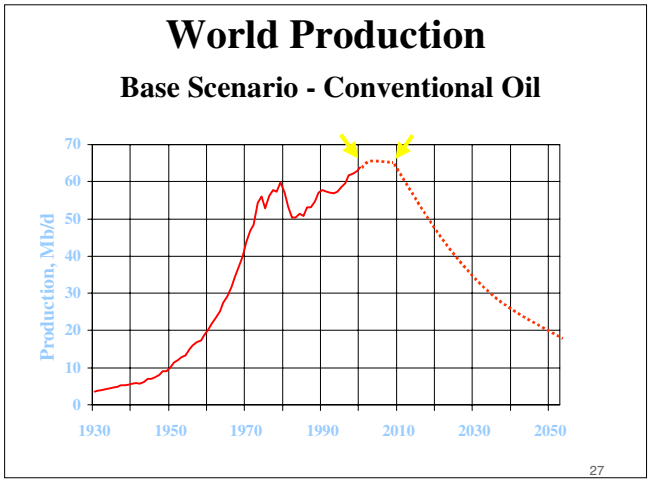
To further develop the idea of *Swing Share,* let's go to the next chart. Oil price is depicted by the vertical green bars. The share in percent of world conventional oil supply from these five Middle East countries is shown by the yellow line. It was 38% at the time of the first oil shock in 1973, but began falling because of fresh production from new giant fields in the North Sea, Alaska and elsewhere. And I stress that these new provinces had already been found. They were not a response to the price shocks as has often been claimed.

Swing Share fell to 18% in 1985. Then it started to rise and it is now about 30%. This time, it is set to continue to rise because there are no new major provinces to come on stream, save perhaps the Caspian, whose ultimate potential is still unknown. On current trends, Swing Share will reach 45% by the year 2005.



<CHART 26> Middle East Gulf Countries – plot of discoveries and production

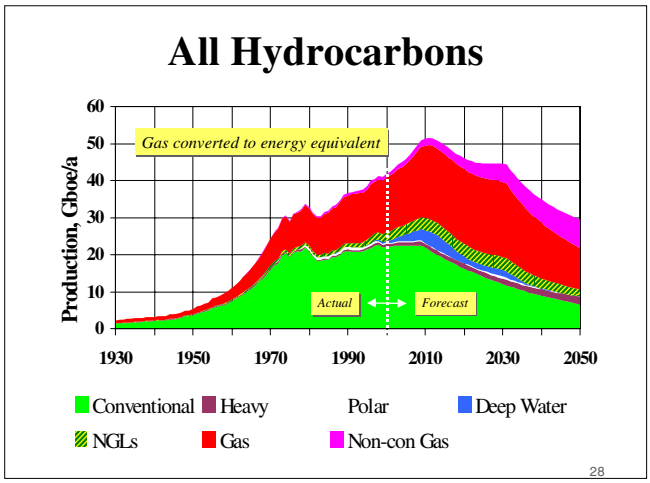
This next chart depicts the discovery and production picture for these five key Middle East Gulf countries. Two key observations here: (1) There have been very few so-called giant discoveries since 1980. And (2) to meet World demand and to compensate for the decline elsewhere in the World, Middle East Gulf production will in a few years be called upon to produce more than it ever has even though its super giant fields are now 27 years more mature since the 1973 embargo. Production will continue to rise and for the foreseeable future will do so unchecked until natural depletion brings about the inevitable decline in about 10 years or so.



<CHART 27> World Production – Base Scenario, Conventional Oil

There are many possible world production scenarios, but let me describe for you my Base Scenario shown in the next chart. It assumes that demand rises at 1.5% a year (a bit below the current level) until Swing share reaches 35% next year as non-swing production—that is the rest of the world—continues its irreversible decline. These events are assumed to convey sufficient control to the Swing countries to impose higher prices.

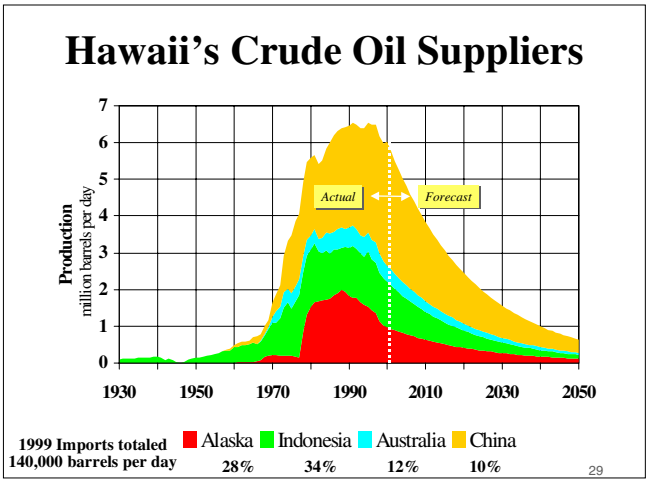
Higher prices curb demand giving a plateau—albeit a very volatile plateau—of production lasting about 10 years. The plateau ends when the Swing share has risen to 50% around the year 2010 and these countries too are close to their mid-point of depletion. Production then falls almost irrespective of price, resulting in the onset of chronic shortages of supply.



<CHART 28>All Hydrocarbons – Production profile

This next chart puts into perspective what I have been talking about. This is a plot of the principal hydrocarbon family production profiles in billions of barrels of oil equivalent per year. The green area is the Conventional Oil that I have been discussing and clearly up to now it has been the major hydrocarbon contributor and it will continue to be the main driver in determining world peak oil production.

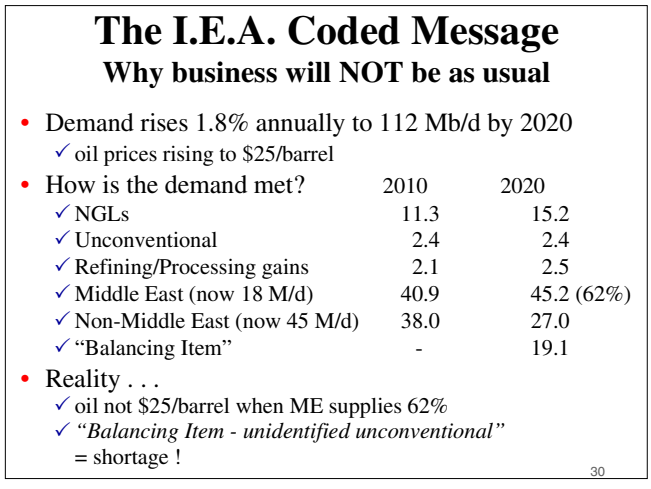
Heavy oil, including tar sand production, is shown in the darker, burgundy color, and it continues to come on slow and steadily. Polar, which is primarily Alaska is shown in white. Deep water, shown in dark blue, will add considerably but by nature of the developments, it will be fairly short-lived, although it will extend peak production by about 5 years. NGLs or Natural Gas Liquids are the yellow/dark green cross-hatched area. NGLs will grow in parallel with Natural Gas shown here in red. On its own, Natural Gas peaks around 2020. Non-conventional gas is shown by the magenta color and includes coalbed methane, tight shale gas, deep water brine gas, HTHP fields, and deep gas in geo-pressured reservoirs.



<CHART 29> Hawaii's Crude Oil Suppliers

This chart illustrates historical and forecast crude oil production for four of the main suppliers of Hawaii" crude oil; namely, Alaska, Indonesia, Australia and China. During 1999 these four supplied nearly 85% of Hawaii's crude oil. Collectively, you can see that they have been declining since the mid-1990s and are projected to continue to do so.

Now you may rightly ask: How valid is this assessment that I have presented today?



<CHART 30>The IEA Coded Message

In their recently published WORLD ENERGY OUTLOOK, the International Energy Agency addressed factors that might impact the quote-unquote "business as usual" scenario. Specifically, the I.E.A. sees oil demand increasing at 1.8% annually to 112 Mb/d by the year 2020 with oil prices rising to $25 a barrel over that same period of time.

The IEA goes on to suggest that this oil demand will be met by: (1) increases in Natural Gas Liquids, (2) increases in "identified unconventional" oil to a maximum of 2.4 Mb/d by 2010, (3) increases in processing/refining liquids, and (4) increases in Middle-East production rising from its current 18 to 45 Mb/d by 2020—at which time it will be 62% of the World's production. The rest of the world meanwhile declines from its current 45 Mb/d to 27 Mb/d by 2020. And then the IEA introduces a term referred to as a "*balancing item-unidentified unconventional*" rising from zero in 2010 to 19 Mb/d by 2020.

Now…I commend the IEA for acknowledging for the first time the concept of depletion and that non-Middle East countries are on decline. But I must ask you: Is their hypothesis credible?

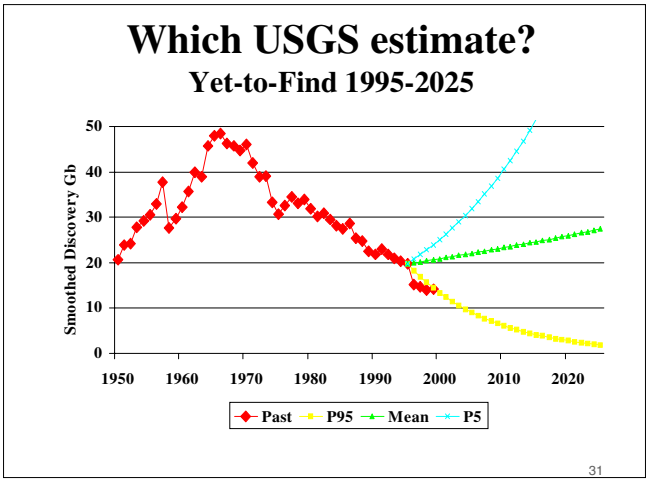
First, to meet the demand increase over the next twenty years—should it come to past—means that today's world-wide oil production would have to increase 55% to meet this target. From what we know about published reserves and remaining potential of all areas of the world, I submit to you that this is not reasonable.

Second, the growing control of the market by the Middle East is, in my opinion, not consistent with $25/b oil by the year 2020.

Third, The Middle East countries may be able to increase production by 200% but I seriously doubt that such a monumental effort would have long term sustainability or be politically palatable within those countries. Why invest in new production if NOT doing so increases or maintains your revenue via higher price?

And, Fourth, we already have <u>huge</u> identified deposits of unconventional reserves, so identification is not the issue. And it is inconceivable to me that production from the hypothetical "unidentified unconventional" oil could rise to 19 Mb/d in ten years when the <u>known</u> unconventional only makes a ceiling of 2.4 Mb/d by 2010. It appears that this "balancing" item is merely a euphemism for production shortages.

In short, I think, the IEA is suggesting that "*business will **NOT** be as usual*". In other words the IEA's position—once you read between the lines—is consistent with that of Dr. Campbell's.



<CHART 31> U.S.G.S. estimate

Last March on the eve of a key OPEC meeting, the United States Geological Survey issued a press statement releasing key findings of an internal study of remaining world oil reserves that had been ongoing since the early 1990s. In June of this year the completed study was issued. The impact of the study was to exaggerate non-OPEC oil reserves and thereby suggest that the United States does not depend on Middle East oil. This point runs counter to all the shuttle diplomacy that Energy Secretary Richardson conducted between Washington DC and Riyadh during the ensuing months of increasing oil prices.

Of course such posturing is normal in the high stakes energy game. OPEC, for its part, exaggerates its resource base to inhibit non-OPEC investments and moves to energy savings or renewables. And oil companies have no vested interested in pronouncing on depletion least their stock price tumbles.

In its latest projection for the 30-year period from 1995 through 2025, the U.S.G.S has failed to live up to its reputation of objective reporting. It has assessed the undiscovered potential of each basin with a range of subjective probabilities. It has a so-called P95 (or probability 95%) case for the most sure estimate and a P5 (or probability 5%) case for the least sure. The P5 case, shown by the blue line, has little meaning. You might as well say that there is a 5% chance that I will evolve into a frog! The P95 value, shown by the yellow line, is a fairly good estimate and is consistent with the actual discovery trend as shown on this chart. But the P5 is meaningless. The Mean value, shown here by the green line, is the one most publicized and it is also meaningless because it is influenced by the P5 value. This has been confirmed by experience in the real world because the Mean estimate is already 70 Gb short after only five years into the study period.

Campbell's Outlook
Pessimistic?

- The 150 Gb of undiscovered reserves
- 30 years of exploration
- 100,000 wildcat wells
- A trillion US$

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<CHART 32> Campbell's Outlook

At current trends, the 150 Gb of undiscovered reserves estimated by Dr. Campbell will take 30 years of exploration, and the drilling of 100,000 wildcat wells at a cost of a trillion US$. And yet many industry experts consider this reserve pessimistic.

Logical Consequences of Peak

- Oil price shock. Demand stabilizes then falls
- Danger of military intervention to secure oil
- Stockmarkets crash
  - ✓Energy smaller % of GNP, but critical %
- Global market ends
- Increased international tensions
- Self-sufficiency becomes a priority

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<CHART 33> Logical Consequences

At this time, I would like to quickly speculate about some of the consequences of the near term peak and the irreversible decline in world oil production.

I have already spoken of the oil price shock. This shock is very different from that of the mid-1970s. It is driven by resource constraints, not politics - although of course politics do enter into it. The market is beginning to perceive that OPEC may have lost control. It is a devastating realization because it means there is no supply-based ceiling on price. Accordingly, prices are set to soar. Don't forget that in to-day's money, oil price went to almost $100 a barrel in the 1970 shocks.

Higher prices will cause demand to stabilize then fall. The poor countries of the world will bear most of the burden.

There is, I think, a strong danger of some ill-considered military intervention to try to secure oil.

A stock market crash seems inevitable with continued high oil prices and the impact that it will have on inflation at interest rates.

Energy costs may be a smaller percent of the GNP today than at the time of the first oil embargo in 1973; but as recent events in Europe have demonstrated, it is a critical percentage. The global market may collapse because of high transport costs and global recession.

I suppose, Europe, Asia and the United States will be on a collision course for access to oil in a world of perceived growing shortage. Canada and Mexico may be under pressure from the USA to increase its imports. In short, it will be a time of great international tension and new alignments. Self-sufficiency will become a priority.

Logical Consequences (con't)

- Gas, NGLs, non-conventionals expand
- Coal, nuclear, fuel cell, wind, solar, ocean expand
- Conservation & energy savings
- Abortive oil exploration boom
  - ✓Caspian success to 3 Mb/d by 2025
- Oil industry restructuring
  - ✓Mergers and downsizing continue

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<CHART 34> Logical Consequences (con't)

Of course, production of gas, NGLs and non-conventional deep-water, heavy oil and polar oil will expand, but in my analysis, they will lessen the decline and will shift the peak by only about 5 years. I imagine coal projects will increase and nuclear power will be rejuvenated in many countries. Fuel cells will take off. And of course solar, wind and ocean generated power will continue to find niche markets and expand.

Consumer energy savings will be in vogue again. Buying local produce (including more organically grown – to get away from costly petroleum based fertilisers) and buying local manufactured goods will make more sense that importing stuff from halfway around the World.

I suppose there will be another oil exploration boom, but that it will be abortive, finding only small fields having negligible world impact, with the Caspian Sea being an exception.

Once the moment-of-truth is realised, that there truly are not many more giants to be found, major integrated oil companies and independents will accelerate mergers and shrink as their throughput falls.

What does this mean for Hawaii?

- Petroleum based average energy costs are going to steadily increase.
- Per capita consumption among the lowest in USA.
- Potential tourists will have less disposal income and face higher travel costs.
- Extend and encourage use of tax credits for solar, wind and thermal energy.
  - ✓Expand to include ocean generated energy
- Promote local produce & manufactured goods.
- Inverted taxes & tariffs on hydrocarbon fuels and hydrocarbon generated electricity.
  - ✓...the more you use it, the more expensive it becomes...
- Energy conservation and education.

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<CHART 35> What does this mean for Hawaii?

Let us consider for a moment what I have just said means for Hawaii insofar as its energy consumption and policies and economy are concerned and I assure you that this slide does not represent an exhaustive list. But, by virtue of its nearly unique geographical and political situation and endowment of natural resources, Hawaii is in a position to become a benchmark state for stewardship and utilization of energy.

Petroleum based energy costs are inexorably going to increase. Crude oil prices on peak will be as volatile as World stock markets are today. Yes, the prices will roller coaster up and down again in the interim due to the interplay of politics and market forces. But these are secondary forces and costs will rise most assuredly with average costs becoming higher and higher as resource constraints ultimately dominate.

On the other hand Hawaii's per capita energy consumption is nearly, if not, the lowest of all the United States, amounting to less than half of the consumption of a Texas resident and merely a quarter of the consumption of an Alaskan. Your favorable tropical climate requires little in the way of heating and air conditioning requirements.

Higher petroleum costs translate to less disposable income and higher air fares for potential tourists. Given the bull market and unprecedented low energy costs of the last 10 years, how will Hawaii's tourist industry fare in a bear or level market and with higher energy costs?

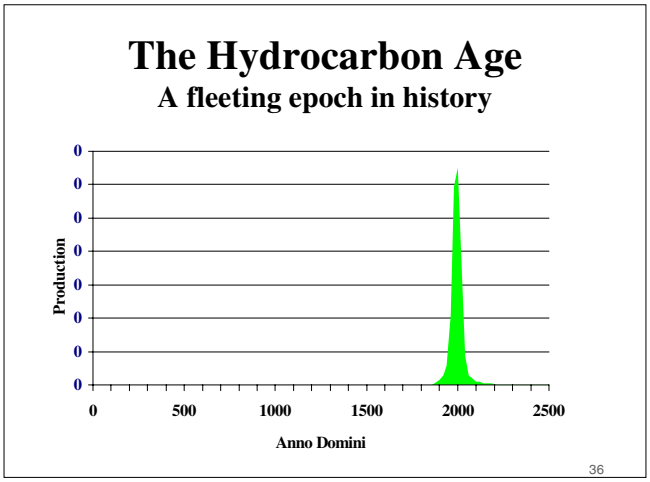
The concept of existing state energy conservation tax credits for solar, wind and thermal energy is to be applauded and further encouraged and extended. And if possible and applicable, expanded to include the use of new kinetic ocean energy technology. Given the necessary lead times, the time has come for increasing the scale of these technologies if they are to ameliorate energy costs.

Assuming cost effective infrastructures, it only makes good common sense anytime you can promote and purchase quality local produce or manufactured goods rather than import the same goods that have been produced and shipped from abroad.

Inverted taxes and tariffs on hydrocarbon fuels and hydrocarbon generated electricity would discourage waste and use while promoting alternative energies. By "inverted", I mean that the more you use it the higher it costs.

Energy conservation and its efficient use and education thereof should become inherent in all we do. For example, business on the mainland have taken the lead to reduce city traffic congestion and save transportation costs by going to so-called 9/80 work schedules; that, is 80 hours worked every 9 work days with every other Friday off. And companies are now encouraging total or partial work at home to avoid commuting and office space costs, while taking advantage of the Internet and world wide computer web to keep people in communication.

<CHART 36> The Hydrocarbon Age



So, in conclusion, I would just like to say that I know that the data points in the oil statistics are weak. But I think that it is better to have a sound-working hypothesis based on available knowledge, than to rely on blind faith alone. Peak oil will be a turning point for mankind. However, the roof does not fall in after peak. What changes are perceptions, as people come to realize that the easy growth of the past becomes the challenge of offsetting the decline of the future. To this end, education of the public, governments and private business sectors as to the realities of global oil supplies will be key to developing a mandate to act on solutions. Let us use our current high oil supply intelligently while it lasts to ease the transition.

Thank you for your attention. Dr. Campbell and I don't pretend to fully understand the situation and we certainly don't have all the answers, but I hope that what I have said will prompt you to reject accepted wisdom and investigate the situation for yourselves as you direct your business.

NOTES

[1] The views expressed are those of the author
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